STUDIES IN ARTOCARPUS AND ALLIED GENERA, III. A REVISION OF ARTOCARPUS SUBGENUS ARTOCARPUS *

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Section **Artocarpus**

Folia adulta et juvenilia simplicia, integra vel pinnatifida; hypodermis absens vel perfecta, cellis isodiametricis composita, rariter imperfecta (*A. blancoi*). *Inflorescentiae* bracteis interfloralibus sparsis vel absentibus. *Capitula mascula* cylindrica vel clavata, rariter ellipsoidea. *Syncarpia* cylindrica vel ellipsoidea, rariter subglobosa, processibus carnosis, firmis vel flexuosis obtecta, vel areolata; ovaria stylis lateralibus vel sub-basalibus; semina testis, pericarpiis, perianthiisque variis inclusa; embryum oblique positum, cotyledonibus aequalibus vel inaequalibus, radicula ventrali.

The classification of this section is discussed in detail above (p. 130). The definition given here does not take into account the characters of the anomalous species.

Series **Incisifolii** Jarrett, ser. nov.

Folia adulta et juvenilia simplicia, integra vel pinnatifida; hypodermis absens vel rariter imperfecta (*A. blancoi*); glandulae immersae, capitibus planis, 8(–16)-cellis. *Inflorescentiae* ramulis latae. *Capitula mascula* superficie plana, floribus fertilibus vel aliquibus sterilis, solidis praelongisque obtecta, bracteis sparsis vel absentibus. *Syncarpia* processibus saepe ex pilis inflatis asperis, aequalibus vel nonnullis solidis praelongisque obtecta; bracteis sparsis vel absentibus; semina testis tenuiter pergamentaceis, rubris vel brunneis, pericarpiis induratis perianthiis tenuisque inclusa.

The rather thick, yellowish, completely indurated pericarp and the relatively well-developed radicle of the embryo are characteristic of this series.

The species of this series are somewhat difficult to define, especially in respect to the vegetative characters and the size of the male heads, but they can readily be identified when bearing syncarps. In all the species pinnatifid leaves may occur on the adult tree, so far as can be judged from the collections seen, whereas such leaves are a juvenile characteristic in the rest of the genus. The indumentum of the leaves and twigs is very variable in both quantity and type. However, the hairs can be classified as follows: short, whitish (if abundant, appearing greyish), rough-walled hairs; short, whitish, smooth-walled hairs with uncinate tips; longer, rufous to

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whitish, smooth-walled hairs. The uncinate hairs are patent, but the other types may be appressed or patent, and straight or somewhat undulate. Some intergrades occur, but the indumentum can usually be described in terms of these three types of hairs, all of which may occasionally (in *A. communis*) occur on the same leaf. The inflated hairs found on the inflorescences, except in *A. communis*, are characteristic of the series.

In considering the species of this series, *Artocarpus pinnatisectus* and *A. multifidus*, both from the Philippines, can first be distinguished from the rest by their deeply pinnatifid, many-lobed leaves, their large anthers 1.2–1.5 mm. long, and the occurrence of elongate, solid, sterile perianths at least in the male inflorescences. The newly described *Artocarpus multifidus* is a very well marked species, although it is based on only two collections, male and female respectively. The inflorescences of both sexes have numerous elongate, solid perianths (projecting 2 mm. in the male head and 15 mm. in the syncarp) with inflated, strongly recurved hairs, and the leaves have seven to ten pairs of lateral lobes. *Artocarpus pinnatisectus* is based on equally limited material, and is not so well defined as a species. In both the collections examined the leaves have twelve to twenty pairs of lateral lobes. The male heads on one of the collections have slightly elongate sterile flowers (projecting only c. 0.5 mm.). The syncarp on the other has no solid processes but in its dimensions (15 × 5 cm., submature), and in the size of the processes (3 × 2 mm.), as well as in the simple styles, it differs from the other Philippine species of the series. While these inflorescences are referred to the same species primarily on the basis of the shape of the associated leaves, their characters are not incompatible with each other and each can be distinguished from all the other species of the series. It should be noted that the absence of a hypodermis in the leaves, the shape of the gland-hairs, the inflated hairs on the syncarp, and also the characters of the embryo and pericarp in *A. multifidus*, justify the placing of these species in series *Incisifolii*, in spite of the differences between them and the other members of the group.

In the remaining species the leaves have not more than five (rarely up to nine) pairs of lateral lobes with shallower sinuses, and only in *Artocarpus communis* are the adult leaves typically incised. In *Artocarpus blancoi*, *A. treculianus* and *A. horridus* the leaves apparently become entire on the mature tree, at least on the smaller twigs. In these four species the anthers are shorter, 0.3–0.8 mm. long, and all the flowers are fertile. In spite of the great variability of *Artocarpus communis*, especially under cultivation, this species is distinguished from the three others by the larger inflorescences, the slender processes on the syncarp, varying to low facets or mere areolae, and the absence of inflated hairs. *Artocarpus horridus*, a new species from the Moluccas, is distinguished primarily by the remarkable, pungent, rufous hairs on the twigs, stipules, petioles and peduncles, but also by the syncarp, which blackens on drying and usually appears cinereous with inflated hairs covering the short-cylindric processes (3 × 1.5–3 mm.). In the Philippine species these hairs are yellow to brown, and the syncarp is not usually nigrescent. The two other species in the

series, *Artocarpus blancoi* and *A. treculianus*, are from the Philippines. Although closely allied to each other, they differ consistently in the characters of the syncarp; the processes in the former are flexuous, projecting 8 to 15 mm., but in the latter they are short-cylindric, projecting to only 4 mm. There also appears to be a difference in the orientation of the embryo, but insufficient material has been examined for this to be certain. The male head in *A. treculianus* is more slender (c. 7 mm. thick instead of 13–20 mm.), and the anthers are shorter (0.3–0.5 mm. instead of 0.8 mm.). The vegetative characters of the two species overlap, but *Artocarpus blancoi* tends to have larger, more pubescent leaves; specimens with small, entire, subglabrous, rhomboid leaves may be assigned with certainty to *A. treculianus*. The two species overlap in their distribution only in central Luzon, and otherwise they occur in areas with a slightly different climate.

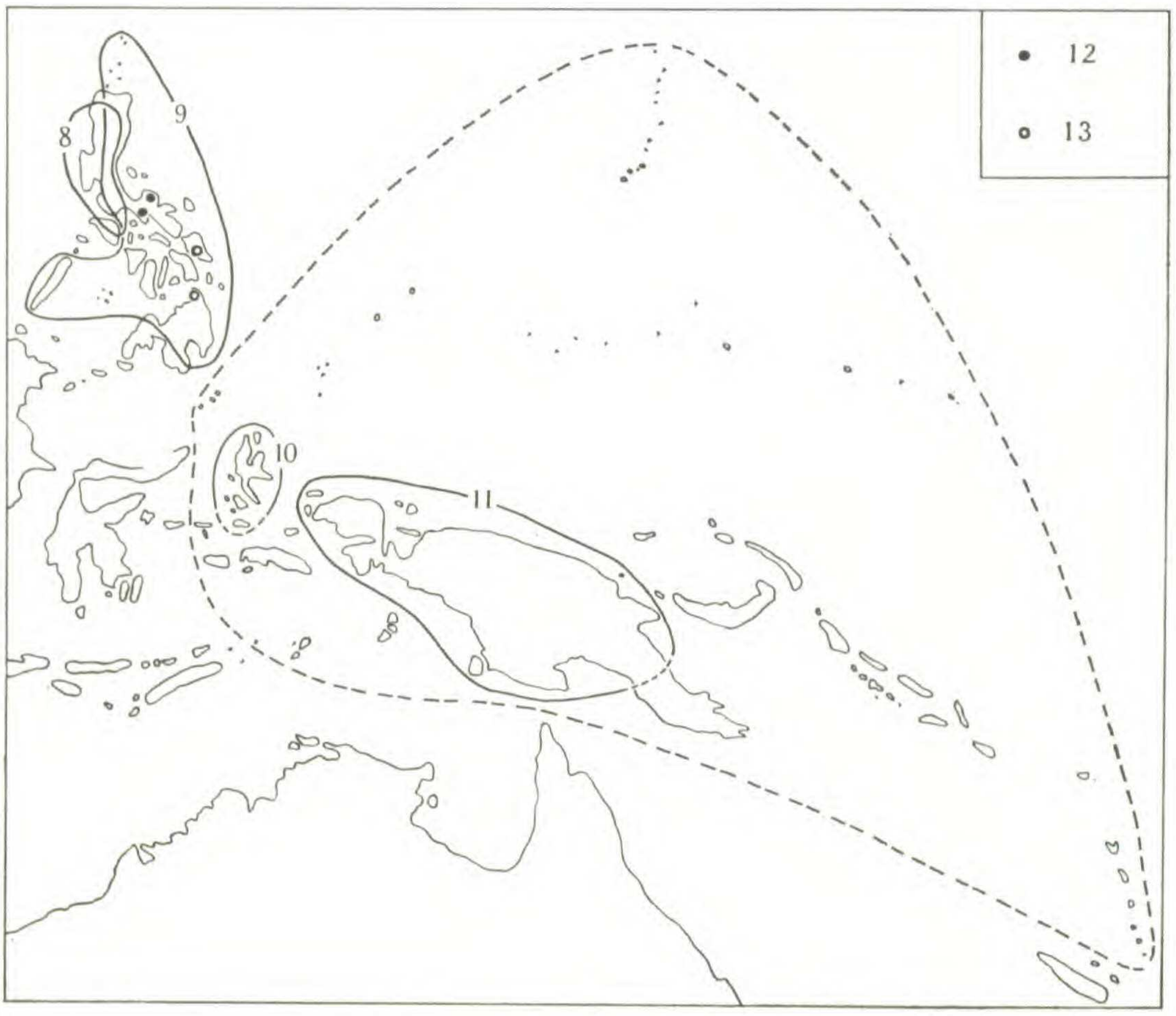

FIG. 12. Distribution of the species of series INCISIFOLII. 8, *Artocarpus blancoi*; 9, *A. treculianus*; 10, *A. horridus*; 11, *A. communis*, distribution as a wild plant — probably indigenous within the area enclosed by the solid line and perhaps also within some part of the region enclosed by the broken line; 12, *A. pinnatisectus*; 13, *A. multifidus*.

There are a few collections referable to this series from the Philippines (all with male inflorescences) which are intermediate in their characters between the species as here defined. It is suggested that these are of hybrid

origin, with *Artocarpus treculianus* as one of the parents; they are described and discussed under that species.

8. **Artocarpus blancoi** (Elmer) Merr. Enum. Philip. Pl. 2: 40. 1923; Quis. Med. Pl. Philip. Is. 226. 1951.

Artocarpus communis blancoi Elmer, Leafl. Philip. Bot. 2: 617. 1909. Holotype, Lamao River, Mt. Mariveles, Bataan Prov., Luzon, *Borden 488* (*FB 1682*), Aug. 1904 (PNH, destroyed, no duplicate seen); neotype, Luzon, *Ramos BS 42018* (K).
Artocarpus communis Forst. var., Merr. Sp. Blancoanae, 124. 1918.
Artocarpus incisa Linn. f. var. *blancoi* Elmer ex Merr. Enum. Philip. Pl. 2: 40. 1923, pro syn., sphalm.
Artocarpus incisus auct. non Linn. f., Blanco, Fl. Filip. 668. 1837, ed. 2. 465. 1845, ed. 3. 3: 75. 1879.
Artocarpus communis auct. non Forst., Merr. Philip. Jour. Sci. 1, Suppl. 43. 1906.

Evergreen trees, height to 15 m. *Twigs* 9–22 mm. thick, shallowly rugose, greyish pubescent, hairs patent or appressed, usually also villous below stipular scars with longer (to 3 mm.), patent, greyish or pale rufous hairs; annulate stipular scars 1 mm. broad, prominent, conspicuous; lenticels scattered. *Stipules* 7–21 cm. long, broadly lanceolate, acute, villous with patent greyish or pale rufous hairs to 3 mm. long, varying appressed-pubescent. *Leaves* c. 20–60 × 20–40 cm., ovate-elliptic, acute, base cuneate or rounded, entire or pinnatifid, lateral lobes 1–3 pairs, broad, acute, sinuses fairly broad, extending halfway to the midrib; main veins prominent beneath, intercostals slightly so; glabrous above except for scattered hairs on main veins, greyish subappressed-pubescent throughout beneath, the hairs rough-walled, straight or slightly undulate, often with longer, greyish, patent, smooth-walled hairs on the main veins; lateral veins c. 12 pairs, straight; intercostals parallel; drying pale brown or greenish, varying dark brown; hypodermis sometimes present, irregular, interrupted, the cells isodiametric in surface view; gland-hairs immersed, heads flattened, 8-celled; petiole 35–130 mm. long.

Inflorescences solitary in leaf-axils. *At anthesis: male head* 100–210 × 12–20 mm., cylindric, smooth, covered by flowers, with or without occasional bracts; perianths tubular, 2 mm. long, bilobed above, the lobes with deflexed, inflated hairs having acute tips; stamen 2.7 mm. long, filament fairly slender, cylindric, anther-cells oblong, 0.7 mm. long; bracts slenderly stalked, heads spathulate, to 0.2 mm. across, pubescent (appearing as tufts of hairs on the surface); peduncle 17–37 × 3 mm., greyish or pale rufous villous, varying appressed-pubescent; *female head* with bifid styles exserted to c. 1 mm. *Syncarp* to 10 × 6.5 cm., ellipsoid, drying yellow-brown to brown, covered by closely set, flexuous, tapering obtuse processes, 8–15 × 1.5 mm., rough from the acute, deflexed tips of dense, inflated hairs; scattered bracts usually present between the processes, slenderly stalked, heads narrowly peltate, to 0.2 mm. across, pubescent; wall c. 2 mm.

thick; fruiting perianths numerous, proximal free region thin, not fleshy, "seeds" (pericarps) ellipsoid, 12 × 9 mm., style sub-basal, testa thinly pergamentaceous, embryo with the radicle ventral, the cotyledons parallel to the median plane of the ovary, equal; core c. 10 mm. across; peduncle 35–60 × 5 mm., indumentum as male.

VERNACULAR NAMES: *Antipolo* or *Tipolo* (Tagalog, Bisayan).

DISTRIBUTION: in lowland forest, in areas with a rainfall of at least 80 inches but a distinct dry season, Mindoro, Luzon.

Philippine Islands. MINDORO. Pinamalayan, *Merrill 2138* (NY, US, ♂). LUZON. Abra: Dolores, *Fenix BS 26714* (US, ♂). Ilocos Sur: *Paraiso FB 25825* (A, US, ♀). Isabela: Ilagan, *Vidal 3847* (K, ♂). Zambales: *Curran FB 5805* (US, ♂). Bataan: Mariveles, *Ahern 787* (US, ♂); Mt. Mariveles, Lamao River, *Barnes FB 527* (K, NY, US), *Borden FB 1297* (NY, US), *1380* (US), *Curran FB 7514* (NY), *Williams 360* (K, NY, US, ♂). Bulucan: Angat, *Ramos & Edano BS 34204* (GH). Rizal: Antipolo, *Merrill SB 214* (A, BO, GH, L, NY, P, US, ♀), *Ramos 1819* (BM, BO, GH, L, P, SING, ♂), *Ramos BS 42018* (A, BO, K, L, SING, US, ♀); San Mateo, *Vidal 1547* (A, K, L, ♀). Laguna: Copeland Height, College of Agriculture, Los Banos, *Sulit PNH 15695* (PNH, ♀). **Cultivated.** LUZON. Manila, Hort. Bot., *Loher 5018* (K, US, ♀).

This species has been identified from Elmer's description and from the two collections cited by Merrill (1923) in raising the variety to specific rank (*Merrill SB 214* and *Ramos 1819*). Merrill (l.c.) stated that *Artocarpus blancoi* also occurred in Palawan, the Batanes Islands, Negros and Mindanao, but he may have been misled by the earlier confusion between it and *A. communis*. In his paper "The Flora of the Lamao Forest Reserve" (1906) he listed several collections under the name *A. communis*, but those which have been seen are all here referred to *A. blancoi* (*Borden FB 1531, 1544, 1624, 1682* are unaccounted for; the last is the type of *A. blancoi*). Other references to *A. communis* as occurring wild in the Philippines are discussed under that species.

The names *Antipolo* and *Tugup* seem to belong to *Artocarpus blancoi* and *A. treculianus* respectively, but they are not always strictly applied. They first appear (the former as *Atipolo*) in G. J. Kamel's account of the flora of the Philippines (Ray, Hist. Pl. 3, App. 52. 1704) and the descriptions there do not conflict with this usage, although they are not sufficiently precise for accurate identification of the species intended.

9. **Artocarpus treculianus** Elmer, Leafl. Philip. Bot. 2: 617. 1909, "*tréculiana*"; Merr. Enum. Philip. Pl. 2: 43. 1923. Holotype, Negros, *Elmer 10406* (PNH, destroyed); isotypes (A, BM, BO, L); lectotype (BM).

Artocarpus nigrescens Elmer, Leafl. Philip. Bot. 2: 614. 1909; Merr. Enum. Philip. Pl. 2: 42. 1923. Holotype, Negros, *Elmer 9795* (PNH, destroyed); isotypes (A, BM, BO, L); lectotype (BM).

Artocarpus ovatifolia Merr. Philip. Jour. Sci. Bot. 9: 268. 1914, Enum. Philip. Pl. 2: 42. 1923. Holotype, Luzon, *Ramos BS 15040* (PNH, destroyed); isotype and lectotype (BM).

Artocarpus ovatifolia Merr. var. *dolichostachys* Merr. Enum. Philip. Pl. **2:** 43. 1923. Holotype, Samar, *Ramos 1603* (PNH, destroyed); isotypes (BM, BO, GH, L, P, SING); lectotype (BM).

Artocarpus sorsogonensis Elmer ex Merr. Enum. Philip. Pl. **2:** 42. 1923, et Elmer, Leafl. Philip. Bot. **10:** 3807. 1939, pro syn.

Artocarpus communis auct. non Forster, Merr. Philip. Jour. Sci. Bot. **3:** 401. 1908.

Evergreen trees, height to 20 m. (–40 m., fide Merrill, 1914), with small buttresses, bark grey. *Twigs* 4–12(–20) mm. thick, shallowly rugose, appressed-puberulent, rarely shortly appressed-pubescent and sparsely villous below the stipular scars with patent, pale rufous hairs; annulate stipular scars c. 1 mm. broad, slightly prominent, conspicuous; lenticels scattered. *Stipules* 5–18 cm. long, lanceolate, acute, cinereous with minute appressed hairs, varying greyish appressed-pubescent. *Leaves* 13–35(–40) × 5–25 (–30) cm., ovate, elliptic or rhomboid, acute or short-acuminate, base cuneate or rounded, entire or pinnatifid, lateral lobes 1–3 pairs, narrow, lanceolate, attenuate, sinuses extending up to two-thirds the distance to the midrib, wide or narrow; main veins prominent beneath, intercostals less so, reticulum scarcely prominent; glabrous above, the main veins only appressed-puberulent beneath, varying to shortly greyish subappressed-pubescent throughout, the hairs rough-walled, straight or slightly undulate; lateral veins 9–12 pairs, straight; intercostals parallel; dark green and glossy above, paler beneath, drying yellow-green to dark brown, usually paler beneath; hypodermis absent; glands sunken, heads flattened, 8-celled; petiole (20–)30–80 mm. long.

Inflorescences solitary in leaf-axils. *At anthesis: male head* 10–210 × c. 7 mm., cylindric, smooth, covered by flowers; perianths tubular, 1–1.8 mm. long, shortly bilobed above, lobes with deflexed, inflated hairs having acute tips; stamen 1.5–2.3 mm. long, filament slender, cylindric, anther-cells oblong, 0.3–0.5 mm. long; peduncle 12–27 × 1–2 mm., appressed-puberulent; *female head* with bifid styles exserted to c. 1 mm. *Syncarp* to 7 × 5 cm. (*Ramos & Pascasio BS 34736*, 11 × 3 cm.; fide *Elmer 9795* to 10 × 7.5 cm.), ellipsoid to cylindric, yellow, drying yellow-brown to brown, covered by closely set, fleshy, cylindric, obtuse processes c. 4 × 2.5 mm., rough from the acute, deflexed tips of inflated hairs; wall c. 2 mm. thick; fruiting perianths numerous, proximal free region thin, not fleshy, "seeds" (pericarps) ellipsoid, 12 × 7 mm., style sub-basal, testa thinly pergamentaceous, embryo with the radicle ventral, the cotyledons transverse to the median plane of the ovary and horizontal or nearly so, the upper one smaller; core c. 10 mm. across; peduncle 20–50 × 2.5 mm., appressed-puberulent.

VERNACULAR NAMES: *Tugup*, *Togop* and variants (Bisayan). USES: the timber is valuable.

DISTRIBUTION: in forest to 2500 ft. in regions with a rainfall of at least 60 inches and the dry season short or absent, Philippine Islands.

Philippine Islands. PALAWAN. Puerto Princesa, Mt. Pulgar, *Elmer 13135* (A, BM, BO, GH, L, U, US, ♀). BATANES ISLANDS. *Fenix BS 3613* (US, ♀). BABUYAN

ISLANDS. Camiguin Island, *Fenix BS 4069* (US, ♀). LUZON. Cagayan: Mt. Tabuan, Bauan, *Ramos BS 77064* (SING, ♀). Isabela: *Alvarez FB 18566* (US, ♂); San Mariano, *Ramos & Edano BS 46941* (BM, NY, ♀). Quezon (Tayabas): Baler, Cemento River, *Quisumbing PNH 2508* (A, PNH, SING, ♀); Casiguran, *Ramos & Edano BS 45408* (A, BM, BO, K, P, US, ♂, ♀); Pagbilao, *Merrill 2848* (BM, NY, P, US, ♀). Laguna: *Ramos 1390* (A, BO, L, P, SING, ♂); San Antonio, *Ramos BS 15040*, June 1912 (BM, ♀), *20530* (K, US, ♀). Camarines: *Alvarez FB 21424* (BM, K, L, P, ♀), *21438* (BM, K, P, ♀), *Vidal 3843* (K, ♀). Sorsogon: *Vidal 3842* (A, K, ♂, ♀); Irosin, Mt. Bulusan, *Elmer 15785* (A, BM, BO, C, GH, K, L, NY, P, U, US, ♀). SIBUYAN. Magellanes, Mt. Giting-Giting, *Elmer 12468* (A, BM, BO, K, L, ♀). TICAO. *Clark FB 1081* (K, NY). SAMAR. *Ramos 1603*, Apr. 1914 (BM, BO, GH, L, P, SING, ♂). LEYTE. Palo, *Elmer 7097* (A, BO, K, ♂). NEGROS. Oriental, Dumaguete, Cuernos Mts., *Elmer 9795*, Apr. 1908 (A, BM, BO, L, ♀), *10406*, June 1908 (A, BM, BO, L, ♀). PANAY. Iloilo, Miagao, *Vidal 3835* (K, ♀). GUIMARAS. *Gammill 310* (NY, US, ♀), *865* (BM, US). MINDANAO. Surigao: *Ramos & Pascasio BS 34736* (A, US, ♀). Davao: *De Mesa FB 27624* (K, US); Todaya, Mt. Apo, *Elmer 10931* (A, BM, BO, K, L, ♀). Bukidnon: near Tanculan, *Fenix BS 24969* (A, P, ♀). **Cultivated.** OKINAWA. Naha, near Yogi Agricultural Institute, *Walker, Tawada & Amana 6051* (A, ♀).

Three specific names based on this species have been published. Of the two species simultaneously described by Elmer (1909), *Artocarpus treculianus* was based on a specimen with entire, pubescent leaves, while *A. nigrescens* was described from a specimen with incised, subglabrous leaves. The type of the third species, *A. ovatifolia* Merrill (1914), has entire, subglabrous leaves. The name of Elmer's second species was derived from his description of the fruits as blackening on the tree. However, these may have been decayed, since all three types have mature or submature syncarps and in the other two descriptions the fruits are stated to be yellow. This is supported by the only field note available, on *Walker et al. 6051*, "fruits yellowish, fleshy, falling before ripe." Therefore, since *A. nigrescens* was based on an erroneous character, *A. treculianus* is here chosen as the name for the species. (Although it is rather surprising that *A. treculianus* should have been introduced to Okinawa, the vegetative characters of the collection cited above are in agreement and the fruit undoubtedly belongs to this species.)

In addition to the characters of the syncarp, this species is distinguished by the consistently slender male heads, but although these have a nearly constant thickness, their length is very variable. The two collections with male inflorescences seen from mid-Luzon (Quezon and Laguna Provinces) have heads 1 to 2.5 cm. long, while the three seen from farther south (Sorsogon Province, Luzon, Samar and Leyte) have heads ranging from 13 to 21 cm. in length. The latter form was distinguished by Merrill as *A. ovatifolia* var. *dolichostachys*, based on *Ramos 1603* from Samar. He had described *A. ovatifolia* from a female collection, *Ramos BS 15040*, but since this came from Laguna Province, Luzon, the distinction is in accord with the limited evidence, which indicates that the variation has a geographical basis. *Artocarpus treculianus*, on the other hand, was described from Negros and presumably represents Merrill's long-headed va-

riety, so that, if the short-headed form were to be regarded as representing a distinct infraspecific taxon, a new name would be needed. However, since only two collections have been seen with the short male head and there is no other distinguishing character, they are not here separated, although future collecting may show that this would be justified.

The majority of the fertile material from the Philippines which is referable to series *Incisifolii* can be assigned readily to one of the species here recognized, but there are a few anomalous collections, all with subglabrous leaves and male inflorescences. These are described briefly below.

Ramos & Edano BS 49334, Mati, Davao Province, Mindanao (SING, ♂): leaves (detached) pinnatifid, lobes 2 or 3 pairs, sinuses extending halfway to the midrib, subglabrous; male head (detached, at anthesis) 115–145 × 9–12 mm., anther-cells 0.8 mm. long, bracts absent, peduncle 25–35 × 2 mm., appressed-puberulent. *Fox PNH 9171*, Karlagen, Pollilo Island (PNH, ♂); twigs and stipules appressed-puberulent; leaves entire, subglabrous; male head (nearly at anthesis) 65 × 12 mm., anther-cells 0.6 mm. long, bracts absent, peduncle 20 × 2 mm., appressed-puberulent. *Curran FB 10164*, Laguna, Luzon (US, ♂): twigs subglabrous; stipules appressed-puberulent; leaves entire, subglabrous; male head (immature) to 40 × 8 mm., a few solid, sterile perianths projecting 0.3 mm. from the surface, anther-cells 0.6 mm. long, bracts scattered, heads spathulate, peduncle 15 × 1 mm., appressed-puberulent. *Curran 3807*, Palawan (BO, K, ♂): twigs and stipules shortly appressed-pubescent, sparsely villous from patent, pale rufous hairs; leaves pinnatifid, lobes 1–2 pairs, sinuses extending one-third the distance to the midrib; male head (immature) 50 × 9 mm., numerous solid, sterile perianths projecting 0.3 mm. from the surface, anthers 0.8 mm. long, bracts scattered, heads spathulate, peduncle 10 × 2 mm., indumentum as twigs.

All four collections could be referred to *A. treculianus* on their vegetative characters, especially the glabrous leaves, but the male heads are too stout, being intermediate in size to *A. blancoi*, and the anthers are too large, agreeing better with the latter species. The last two collections differ from both these species in having sterile flowers, as well as interfloral bracts. They cannot be assigned to *A. pinnatisectus* or *A. multifidus*, however, because of the small anthers (which in these species measure 1.2–1.5 mm.) and, on present evidence, because of the shape of the leaves. It is suggested that these collections are from trees of hybrid origin and that the characters of the first two can be accounted for if they represent *A. treculianus* × *A. communis*. The difference in the size of the male heads would correspond to the variation in *A. treculianus*. The second two collections could represent hybrids of *A. pinnatisectus*, perhaps also with *A. treculianus*, although the former species has not been collected in Palawan. In *Curran FB 10164* the pollen grains are shrunken, but they are apparently well formed in the first two collections. However, although this is one explanation of the characters of these collections, basing the parentage partly on geographical evidence, the first two collections, at least, may represent merely a wider range of variation in *A. treculianus* than is here recognized.

10. **Artocarpus horridus** Jarrett, sp. nov. Holotype, Halmaheira, *Beguin 1976* (L); isotypes (BO, L).

Soccus silvestris Rumphius, Herb. Amb. **1:** 114. *t. 34.* 1741.
Artocarpus communis Forster var. *pungens* J. J. Smith ex Heyne, Nutt. Pl. Ned. Ind. ed. 2. **1:** 557. 1927, non *Artocarpus pungens* (Lesquereux) Hollick, Geol. Surv. Louisiana Spec. Rep. **5:** 281. *t. 38, figs. 1, 2.* 1899.
Artocarpus elasticus auct. non Reinw. ex Blume, Hassk. Abh. Naturf. Ges. Halle **9:** 158. 1866; Merr. Interpr. Rumph. Herb. Amb. 191. 1917.

Syncarpia cylindrica, ad 9 × 4.5 cm., processibus crebris, brevibus, cylindricis, obtusis, canis ex pilis inflatis, vel glabris obtecta; folia integra vel pinnatifida, glandulis immersis, capitibus planis, 8-cellis; ramuli, stipulae, petioli, pedunculique horridi, pilis patentibus, rigidis, aciculiformibus, rufis, 2 mm. longis.

Arbores ad 35 [–40] m. altae. *Ramuli juniores* 12 [6–15] mm. crassi, rugosi, horridi, pilis patentibus, rigidis, aciculiformibus, rufis, 2 mm. longis, numerosis ad paucis, nec non appresse puberulentes; cicatrices stipularum annulatae, 1 mm. latae, prominulae, conspicuae; lenticellae infra cicatrices circum ramulos dispositae. *Stipulae* 9 [6–27] cm. longae, horridae, pilis ut ramulis, appresseque pubescentes, pilis canescentibus. *Folia* c. 30 × 20 [20–70 × 10–55] cm., ovati- [vel rhomboido-]elliptica, breviter acuminata, basi rotunda vel cuneata, subintegra, laciniis lateralibus utrinque 3, brevissimis, [integra vel pinnatifida, sinusibus angustis, laciniis utrinque ad 9, lanceolatis, acutis vel breviter acuminatis,] supra saepe appresse puberulentia, costa nervis lateralibus transversalibusque subtus prominentibus, undique appresse pubescentibus, [saepe] horridisque, pilis ut ramulis, venulis subtus prominulis, in sicco rufi-brunnea; nervi laterales utrinque 11–18, recti; nervi transversales paralleli; hypodermis absens; glandulae immersae capitibus planis, 8-cellis; petiolus 45–90 mm. longus.

Inflorescentiae axillis foliorum solitariae. *Ad anthesin: capitula mascula* c. 50 × 15 [50–95 × (5–)15–23] mm., cylindrica, plana, floribus numerosissimis obtecta; perianthia tubulosa, 1 mm. longa, supra bilobata, glabra vel pilis paucis, inflatis, apicibus acutis deflexis; stamina 1.6 mm. longa, filamentis cylindricis cellis antherum oblongis, 0.6 mm. longis; pedunculus 20–35[–50] × 5 mm., indumento ut ramulis; *capitula feminea* stylis bifidis 2 mm. exsertis. *Syncarpia* 5.5–9 × 3(–4.5) cm., cylindrica [vel subellipsoidea], flava, in sicco nigrescentia, processibus crebris, solidis, cylindricis, obtusis, 3 × 1.5–3 mm., canis ex pilis inflatis, apicibus acutis, deflexis, vel glabris, obtecta; pedunculus c. 80 [(–110)] × 6 mm., indumento ut ramulis.

VERNACULAR NAMES: *Dinga*, Halmaheira, Ternate; *Pongo*, Halmaheira.

DISTRIBUTION: in evergreen forest to 1000 ft., the Moluccas (Halmaheira group).

Moluccas. MOROTAI. Totodoku, *bb 33816, 33817, 33864,* (L); W. Pitu, *Beguin 2223* (BO, L, ♂, ♀). HALMAHEIRA. Djailolo, Togoair, *bb 23731* (BO, L); Galela, *Beguin 1954* (BO, L, ♂, ♀); Galela, Soa Tobara, *Beguin 1906,* (BO, L, ♂), *1908*

(BO, L, ♀), *1975*, *1976*, May 1922 (BO, L, ♂, ♀); Kp. Goal, *Pleyte 190* (L); W. Tobelo, *Beguin 2293* (BO, ♀), *2295* (BO, K, L, ♀). TERNATE. Foramadiahi, *Beguin 1233* (BO, L, ♂, ♀). BATJAN. Saoran Domut, *bb 23200*, *23204* (BO, L).

Artocarpus horridus is remarkable for the sharp, rigid hairs on the twigs and peduncles, which make specimens unpleasant to handle, and from which the specific epithet is derived. These hairs, combined with the frequently entire leaves and the relatively small syncarp (as compared with *A. communis*), enable the species to be identified with Rumphius' *Soccus silvestris*, or *Soccun Utan*, with certainty. J. J. Smith labelled the Beguin collections as *Artocarpus communis* var. *pungens*, but the name was not published until Heyne took it up in 1927. The latter, however, did not provide a description or cite Beguin's collections, but identified the variety correctly with Rumphus' description and plate, so that these must be regarded as the type of Smith's name. Rumphius recorded the species from Amboina and adjacent islands.

The collections seen are rather variable in the shape of the leaves and the inflorescences and in their indumentum, but at least a few rigid hairs are always present. Large, pinnatifid leaves and numerous rigid hairs appear to be correlated with stout inflorescences having dense inflated hairs, while specimens with small, entire leaves and sparse rigid hairs have slender, subglabrous inflorescences. The first type may represent collections made from young trees or juvenile shoots.

11. **Artocarpus communis** J. R. & G. Forster, Char. Gen. 101. *t. 51, 51a*. 1776. Holotype, without provenance, *Forster s.n.* (BM); ? isotype, Tahiti (K).

Camangsi, *Rhymay Marianorum* et *Dugdug Marianorum* Kamel in Ray, Hist. Pl. **3**, App. 52. 1704.

Soccus lanosus Rumphius, Herb. Amb. **1**: 110. *t. 32*. 1741.

Soccus granosus Rumphius, l.c., 112. *t. 33*.

Sitodium-altile [Banks & Solander ex] Parkinson, Jour. Voy. Endeavour, 45. 1773, nomen subnudum.

Rima Sonnerat, Voy. Nouv. Guin. 99. *t. 57–60*. 1776.

Rademachia incisa Thunb. Vet. Akad. Handl. Stockholm **37**: 253. 1776; Houttuyn, Nat. Hist. II. Pl. **11**: 449. Holotype, Java, *Thunberg s.n.* (UPS, not seen); ? isotype (L).

Sitodium incisum Thunb. Philos. Trans. Roy. Soc. London **69**: 465. 1779, nomen illegitimum.

Artocarpus incisus Linn. f. Suppl. Pl. 411. 1781.

Artocarpus incisifolia Stokes, Bot. Mat. Med. **4**: 331. 1812, nomen illegitimum.

Artocarpus nucifera [Thompson,] Cat. Maurit. 25. 1816, nomen nudum.

Arctocarpus camansi Blanco, Fl. Filip. 670. 1837.

Arcthocarpus rima Blanco, l.c., 671.

Artocarpus laevis Hassk. Flora **25**(2), Beibl. 18. 1842. Holotype, Java, Batavia (cult.), *Hasskarl s.n.* (L).

Artocarpus mariannensis Tréc. Ann. Sci. Nat. Bot. III. **8**: 114. 1847. Holotype, Marianas Islands, *Gaudichaud s.n.* (P).

Artocarpus incisa Linn. f. *β laevis* Miq. Fl. Ind. Bat. **1**(2): 285. 1859.

Sitodium utile Solander ex Seem. Fl. Viti. 255. 1868, pro syn., errore pro *Sitodium altile*.

Artocarpus incisa Linn. f. var. *muricata* Becc. For. Borneo, 628. 1902. Holotype, New Guinea, *Beccari PP 25* (FI).

Artocarpus leeuwenii Diels, Bot. Jahrb. **67**: 175. 1935. Holotype, New Guinea, *Docters van Leeuwen 11163* (B, not seen); isotypes (BO, L, U).

Artocarpus papuana Diels, l.c., nomen illegitimum, non *A. papuanus* Renner, 1907. Holotype, New Guinea, *Ledermann 7513* (B); [5] isotype (SING).

Artocarpus altilis (Parkinson) Fosberg, Jour. Wash. Acad. Sci. **31**: 95. 1941, nomen subnudum.

Evergreen or deciduous trees, height to 35 m. *Twigs* 5–15 mm. thick, smooth or rugose, greyish appressed-pubescent, with or without patent rufous hairs below the stipular scars or rarely throughout, varying to glabrous; annulate stipular scars c. 1 mm. broad, slightly prominent; lenticels none or scattered. *Stipules* 10–25 cm. long, lanceolate or broadly lanceolate, greyish or rufous appressed-pubescent, varying to subglabrous. *Leaves* 15–17 × 10–50 cm., rhomboid, varying to elliptic or ovate in outline, base rounded or cuneate, pinnatifid, varying to entire; lateral lobes 1–5(–9) pairs, lanceolate, attenuate, sinuses narrow, extending up to two-thirds the distance to the midrib, varying to deeply pinnatifid with broad sinuses; main veins prominent beneath, intercostals slightly so; puberulent to pubescent on both surfaces with straight, white, usually appressed, rough-walled hairs and/or uncinate, white, patent, smooth-walled hairs, with or without longer rufous (rarely white) appressed, smooth-walled hairs on the main veins, varying to glabrous (seedless cultivars usually subglabrous except on the main veins); lateral veins 9–12 pairs, straight; intercostals parallel; green, usually drying brown to pale brown; hypodermis absent; gland-hairs immersed, heads flattened, 8-celled; petiole 30–60 mm. long.

Inflorescences solitary in leaf-axils. *At anthesis: male head* 70–300 (–400) × 15–30(–55) mm., narrowly to broadly cylindric or clavate, rarely ellipsoid, smooth, covered by flowers; perianths tubular, 1–1.5 mm. long, bilobed above, sparsely pubescent or glabrous; stamen 1.6–2.4 mm. long, filament cylindric, anther-cells oblong, 0.6–0.8 mm. long; peduncle 30–60 × 3–6 mm., greyish or rufous villous to glabrous; *female head* with bifid or simple styles exserted up to 2 mm. *Syncarp* (? 10–)15–30 cm. across, cylindric, obovoid, ellipsoid or globose, green to yellow, drying brown to black, covered by closely set, flexuous, attenuate or conical, acute processes, projecting to 15 mm., to 5 mm. across at the base, varying to low facets, or (in seedless cultivars) with the surface merely areolate, pubescent or subhispid with slender patent hairs, varying to glabrous; fruiting perianths numerous, proximal free region thin, not fleshy, "seeds" (pericarps) obovoid-oblong, irregularly compressed, c. 25 × 20 × 15 mm., the style lateral, two-thirds the distance up the ventral face, testa thinly pergamentaceous, embryo with the radicle ventral, the cotyledons somewhat oblique to the median plane of the ovary, the lower one slightly larger

[5] It is regretted that the name of the Botanisches Museum, Berlin-Dahlem, Germany, (B), was inadvertently omitted from the list of institutions to which grateful acknowledgement is made for the loan of specimens.

and shallowly folded (cultivars frequently with few or no seeds, the perianths hypertrophied to form starchy edible tissue and the undeveloped ovaries surrounding the core); peduncle 35–135 × 5–10 mm., greyish or rufous villous to glabrous.

VERNACULAR NAMES. (1) General: Breadfruit, restricted to the seedless form in Africa and the New World; Breadnut, seeded form, in the latter regions; Arbre à Pain; etc. (2) Malaysia: *Kulur*, *Kulor* or *Kuror*, seeded, and *Sukun* or *Soccun*, seedless (Malay), Malaysia excluding the Philippines; *Kluwih*, seeded and *Timbul*, seedless (Sundanese), Java; *Camansi*, seeded, and *Rima*, seedless (Tagalog and Bisayan), Philippines; *Gomo*, Moluccas. Only some common forms of the more widely distributed names are given here; Heyne, Nutt. Pl. Indonesië ed. 3. 1: 555. 1950, gives many local names and variants. (3) Pacific: *Dugdug*, seeded, and *Lemai*, seedless, Marianas Islands; *Mai* or *Mei*, Caroline, Marshall, Ellice, Samoa and Marquesas Islands, Niue (e. of Tonga Islands) and Mangareva; *Uto*, Fiji; *Ulu*, Tonga, Samoa and Hawaiian Islands; *Uru* partially replaced by *Maiore*, Society and Austral Islands; *Kuru*, Cook Islands and Mangareva.

USES. The fruit of both the seeded and the seedless forms is an important article of diet in some regions. In New Guinea, Melanesia and the Moluccas the form of chief importance is that with seeds, and these are eaten roasted or boiled. Elsewhere, the seedless form is more commonly cultivated, and in the Pacific it provides the inhabitants of some island groups with a major source of carbohydrate. Different varieties may bear for only a limited period, but a succession of them can provide fresh fruit for most of the year, although the time and length of season, or seasons, varies in the different islands. The fresh fruit is eaten after being cooked by roasting or boiling. The fruit is preserved for the time when it is out of season by being made into a fermented paste which is stored in pits lined with leaves (of *Cordyline* or coconut) and covered with leaves and stones, where it will keep for several months. The paste is called *mar* or *maratan* in the Carolines, *masi* in Samoa and *mahi* in Tahiti. The fruit may also be cut into slices and dried, usually in the sun, for storage. Neither form has become of equal importance elsewhere in the tropics, but the seedless form is widely used as a vegetable, as also is the young fruit of the seeded form in Malaysia. The latex is used in New Guinea and the Pacific for bird-lime and for caulking boats, and the young bark is sometimes used for making *tapa* cloth. The wood is used in the Pacific for building houses and for furniture, but it is of variable quality and is not much valued in other regions.

DISTRIBUTION. Seeded form: probably indigenous in New Guinea, where it is scattered in (?) primary rain forest and is locally abundant in secondary forest on alluvium; perhaps indigenous in Micronesia, where it is a prominent member of the forest on some "high" islands, especially on coralline limestone, and also in Melanesia and the Moluccas; cultivated throughout the tropics (locally naturalized in secondary vegetation, e.g., in Luzon) but rare in Polynesia and generally less frequent than the seed-

less form, except in New Guinea, Melanesia and the Moluccas. Seedless form: cultivated throughout the tropics; many cultivars are distinguished, especially in Polynesia.

Lesser Sunda Islands. TANIMBAR ISLANDS. Lurumbun, *bb 24430*, P [6] (L). **Moluccas.** TALAUD ISLANDS. Karakelang, Gunong Duata, *Lam 2895*, P (L). SULA ISLANDS. Kali Waj Gaj, *bb 28813*, P (BO).

New Guinea. VOGELKOP. Inanwatan, Tisa, *bb 32639*, P (BO, L); Manokwari, Momi, *Kostermans 189*, P (BO, K, L); Manokwari, Prafi, *NIFS BW 453* (L, ♂, ♀); Manokwari, Warnapi, *bb 33667*, P (BO); Tangion Bair [= Biak], *Beccari PP 25*, Apr. 1872 (FI, ♀); Tanibo, *bb 25517*, P (BO, L). DUTCH NORTH NEW GUINEA. Bernhardbivak, Idenburg River, *Brass & Versteegh 13537*, P (A, ♀), *bb 25680*, P (BO, L, SING, ♂, ♀); Hollandia, n. of Kobroor, *bb 25347* (L); Meervlakte, Motorbivak, Bruine River, *Docters van Leeuwen 11163*, R, Nov. 1926 (BO, L, U, ♂, ♀); Pioneerbivak, Mamberamogebiet, *bb 31100*, P, *bb 31306*, P (BO); Prauwenbivak, *Lam 927* (BO, L, U, ♂, ♀); Sennen, 30 km. inland from Nabire, *Kanehira & Hatusima 12580*, R (A, BO, ♂). DUTCH SOUTH NEW GUINEA. Lorentz River, *Von Römer 154* (BO, L, ♂, ♀); Mimika, Uta, Aria, *bb 32858*, P (L); Mimika, Uta, Najaja, *bb 32851*, P (L). PAPUA. Central Division: near Port Moresby, *Edelfeldt 51* (L); Sogeri, *Forbes 158* (BM, ♀); Veiya, *Carr 11633*, R (A, K, ♀), *11675*, S (A, K, ♂). Gulf Division: Vailala River, Lipokira, *Brass 981*, ? cultivated (A, ♂, ♀). Northern Division: Isuarava, *Carr 15726*, S (A, K, ♀). MANDATED TERRITORY OF NEW GUINEA. Morobe District: Markham Valley, Kajabit, *Clemens 40696* (A, ♂); Sattelberg, *Clemens 1117* (A, L, ♂, ♀, ? mixed collection). Sepik District: mouth of April River, *Ledermann 7513*, R, June 1912 (B, SING, ♂, ♀). ARU ISLANDS. P. Kobroor, *bb 25347*, P (BO).

The nomenclature of the Breadfruit is discussed in detail above (p. 118) where it is concluded that the correct name is *Artocarpus communis* J. R. & G. Forster (1776). The combination *Artocarpus incisus* (Thunb.) Linn. f. (1781), based on *Rademachia incisa* Thunberg (1776), which was made by Linnaeus *filius* when he chose *Artocarpus* over *Rademachia*, is rejected on the grounds that an earlier legitimate name was available for the species and should have been used. The earliest published Linnaean binomial for the Breadfruit, *Sitodium-altile* |Banks & Solander ex| Parkinson (1773) [7] on which *Artocarpus altilis* (Parkinson) Fosberg (1941) is based, is also rejected since the account to which it is attached is considered to be inadequate as a generico-specific description.

Artocarpus communis is based solely on the seedless form of the Breadfruit. The type is presumably the Forster specimen in the British Museum (Natural History) consisting of a single incised leaf without provenance.

[6] The following abbreviations are used to indicate the type of forest from which the collection was made: P, old or primary; R, riverside; S, secondary.

[7] A comment may be added here on the hyphenation of the Latin names attached to the series of notes on Tahitian plants in Sydney Parkinson's journal. There is no definite reason for supposing that Stanfield Parkinson added the hyphens in editing his brother's work for publication. On the other hand, the hyphenation by Sydney Parkinson of Solander's manuscript names, in adding them to his notes, is probably an insufficient reason for rejecting the work as one in which binomial nomenclature is not used. The hyphens should be regarded as an orthographic error.

Another specimen collected by Forster, also a single leaf, which is in the herbarium at Kew, was collected on Tahiti, and this may be an isotype. The illustrations in the original account show the male head as narrowly cylindric, the syncarp as subglobose with low facets, and the peduncles of both as sparsely villous. *Sitodium-altile* was likewise based on the seedless Breadfruit of Tahiti. Thunberg's *Rademachia incisa* was described from Java and included both the seedless and seeded forms of the Breadfruit, which he designated as "α.) Pericarpio sterili, muricato, sulcis inter germina reticulato, . . . ," and "β.) Pericarpio fertili, germinibus productis & pistillis longis echinato; . . . ," respectively. The vegetative characters appear to be taken from the seeded form, since the leaves, petioles and peduncles are described as villous and the seedless form in Java is glabrous or nearly so.

The Breadfruit is cultivated throughout the tropics in both seeded and seedless forms, but in most areas the seedless form is more commonly grown and is of considerably greater importance. A review follows of the variation exhibited by both forms throughout their present ranges, together with a discussion of the ecological status of the former. This survey can be only preliminary, since in most areas insufficient evidence is available concerning the details of variation. A conservative taxonomic treatment is therefore adopted. The aim here is to draw together from a wide geographical area and range of literature the information that is available, and to present the taxonomic problems, thus providing a basis for future, more detailed studies.

Although further studies may show that two or more subspecies or closely allied species are involved, it is tentatively concluded that the Breadfruit, whether seeded or seedless, represents a natural but rather variable species which has been considerably modified under man's influence. The seeded Breadfruit appears to be indigenous in New Guinea and perhaps also in the Moluccas, Melanesia and Micronesia. Some, at least, of the few-seeded or seedless varieties were developed in New Guinea, but others may have arisen from seeded Breadfruit growing in Micronesia, Melanesia and the Moluccas.

In the literature the place of origin of the Breadfruit has been indicated in general terms as the Sunda Islands or Malaysia (e.g., Alphonse de Candolle, Orig. Pl. Cult. 238. 1882), or else as the Pacific (e.g., Burkill, Dict. Econ. Prod. Malay Penin. 250. 1935). It has often not been made clear whether both the seeded and the seedless forms were under consideration, or the latter alone. The fairly consistent and marked differences which exist over wide areas (but not in New Guinea or the Pacific) between the two cultivated forms have led some authors, including Quisumbing (Philip. Jour. Sci. 70: 331. 1940), to suggest that they originated from two distinct wild species. However, as already indicated, a broad view is here taken of *Artocarpus communis*. Moreover, if two or more taxonomic entities should be involved in the ancestry of the Breadfruit, a complex hybridization between them has apparently taken place. It will be shown below that the differences between the seeded and seedless forms

can be accounted for in part by their distribution from different sources.

The distinctions between *Artocarpus communis* and the allied species of series *Incisifolii* are indicated above in discussion of the series. The principal characters in which variation occurs within the species, including cultivars, are the outline and indumentum of the leaves, the shape and size of the male head, the shape, size and surface of the syncarp, and whether or not seeds are formed. Before proceeding with a description of the Breadfruit by geographical areas, the possible causes and consequences of the development of sterility will be discussed.

First, however, it must be pointed out how very inadequate the herbarium material — most of which is sterile — has been as a basis for this survey. For comparative studies over a wide area, material which gives as full a picture as possible of trees representing different variants of the seeded and seedless forms would be of very great interest. The difficulty of making successive collections from a single tree is recognized, but ideally the following material would be necessary: (1) one or more leaves attached to a twig (having a terminal bud enclosed by stipules), with notes on the variation in leaf-shape on different parts of the tree; (2) two or three male inflorescences at anthesis to show the range of variation in shape; (3) a female inflorescence at anthesis; (4) a longitudinal slice of the mature fruit dried rapidly to prevent decay (showing outline, surface, and whether or not seeds are present); (5) drawings or, preferably, photographs to show the habit of the tree and the shape and arrangement of the fruit; and (6) notes on the colour and uses of the fruit and wood, the mode of propagation, vernacular names, etc. If collections can be made only at the time of anthesis, both male and female inflorescences should be gathered. In order to carry out more detailed studies and to establish the cause of the failure to form seeds, field and experimental work in the tropics will be necessary. I am glad to learn from Dr. F. R. Fosberg, Pacific Vegetation Project, National Research Council, Washington, D.C., that such a survey may be carried out in the Pacific region.

The presence or absence of seeds must be treated independently from other variation in the species, and the possible genetic basis and consequences of the sterility considered. Correlations existing between the seeded or seedless character and other variation will be indicated below. The evidence available from the literature shows that triploidy occurs in the seedless form. Chromosome numbers equivalent to a diploid number of 56 have been recorded in *Artocarpus heterophyllus* (Subba Rao, Half-Yearly Jour. Mysore Univ. Sect. B. Sci. 1: 63. 1940; Janaki-Ammal in Darlington & Wylie, Chromosome Atlas ed. 2, 184. 1955), *A. lakoocha* (Banerji & Hakim, Proc. Ind. Acad. Sci. B. 38: 128. 1954) and seeded *A. communis* (Nishiyama & Kondo, Seiken Zihô 1: 26. 1942, reference not seen; Janaki-Ammal in Darlington & Janaki-Ammal, Chromosome Atlas, 184. 1945). A somatic chromosome number of c. 81 has been recorded for seedless *Artocarpus communis* (Nishiyama & Kondo, l.c.). These counts suggest that the basic number for *Artocarpus* is 28 and that the seedless Breadfruit is triploid ($3n = 84$), at least in the example under study. As a genus,

Artocarpus appears to be tetraploid with respect to the basic number of 14 that occurs widely in the Urticales. Darlington and Wylie gave the basic number of *Artocarpus* as 14, but their data were derived in part from Krause's study of chromosome numbers in the Moraceae (Planta 13: 29. 1931), and unfortunately the only species studied by the latter was *A. cannonii* W. Bull ($2n = 28$), which had been transferred correctly to *Ficus* by N. E. Brown in 1888. Thus there is as yet no evidence that the diploid number of 28 occurs in *Artocarpus*.

Further investigation will be required to determine whether or not triploidy is the primary cause of the failure to form seeds. The simple occurrence of triploidy would not necessarily result in the formation of a fleshy, edible fruit and it is more likely to have been a secondary development as, for example, in the banana. Some fruits with very few seeds have been seen on collections from New Guinea (e.g., *Carr 11633*), and in Tahiti and Java varieties are recorded with fruits which are eaten for their flesh but which usually have a few seeds. This tendency to develop only a few seeds may well be due to genetic factors other than polyploidy. Both of the latter varieties are propagated by vegetative means, and Heyne (Nutt. Pl. Indonesië ed. 3. 555. 1950) states that the seeds are not viable in the Javan variety. If triploidy were to arise in such a variety it might be expected to produce more complete sterility and, other things being equal, the triploid plant would presumably tend to be selected.

The seedless varieties of the Breadfruit are most commonly propagated by means of root cuttings and root suckers and the formation of the latter is stimulated by deliberate injury of the roots. Each variety is thus a clone within which the primary source of variation is presumably somatic mutation. This will be the chief means by which new varieties can arise in areas where the seeded form is rare or absent, and that such mutations do occur is evident from comments given with lists of varieties from the Pacific. As suggested by Fosberg (Botanical Report on Micronesia. U. S. Commercial Company Economic Survey of Micronesia. 1946), back-crossing may occur between the seedless and seeded forms of the Breadfruit. If fertile pollen is produced by a seedless variety it may fertilize a seeded variety and carry over characters of the former, including those that have arisen by somatic mutation, thus adding to the general pool of variability in the seeded form. If a genetically determined inability to produce seeds is also transmitted, a new seedless variety may be formed that combines characters of both the seedless and the seeded parents. A triploid seedless variety might be expected to produce occasional haploid and diploid grains which could result in diploid and triploid progeny (the latter, at least, seedless) on successful pollination of the seeded form. Conversely, though less frequently, diploid and triploid (and presumably also tetraploid) progeny might be grown from occasional seeds formed in a usually seedless variety.

The range of variation exhibited by seedless varieties must depend primarily on that of the seeded plants from which they have arisen. The variation observed indicates that only autotriploidy has occurred, if the broad view here taken of *Artocarpus communis* is accepted. There is no taxonomic

evidence from the characters observed that hybridization with the allied species here recognized has occurred during the development of the seeded or seedless Breadfruit. In addition, historical evidence, outlined below, makes it unlikely that the Philippine species, at least, could have taken part in any hybridization. However, although no infra-specific taxa are here proposed within *Artocarpus communis*, this does not exclude the possibility that, when more detailed evidence based on a wide range of vegetative and inflorescence characters is available, two or more subspecies, or closely allied species, in the New Guinea and western Pacific regions may be shown to have been involved in the ancestry of the Breadfruit as it is known today. Many varietal names have been proposed for the seedless as opposed to the seeded form of Breadfruit, but such taxa can only be descriptive, since in different areas there is great and overlapping variation in both forms and the origin of the seedless form is probably complex.

The following subdivision of the areas in which the Breadfruit occurs, according to the status and relative importance of the seeded and seedless forms, is given as a basis for the review which follows: (1) area in which the seeded form is predominant, very variable and probably indigenous — New Guinea and perhaps the Moluccas and Melanesia; (2) area in which the seedless form is predominant and very variable — the Pacific; (2a) area in which the seeded form is a conspicuous and possibly indigenous component of the vegetation — Micronesia; (2b) area in which the seeded form is rare — Polynesia; (3) area in which the seeded and seedless forms are rather constant in their characters and distinct from each other — the remainder of the tropics.

In New Guinea the Breadfruit is of widespread occurrence, especially in its seeded form. It was recorded by Miklouho-Maclay (Proc. Linn. Soc. N. S. Wales **10**: 348. 1885; as *A. incisa* and *A. integrifolia*) in the Astrolabe Bay area of Northeast New Guinea, both in cultivation and in the forest, and by Warburg for Finschhafen and the Bismarck Archipelago (Bot. Jahrb. **13**: 295. 1891). Lauterbach (l.c. **63**: 421, 438, 444, 447. 1930) stated that wild Breadfruit occurred in the Astrolabe Bay area both on the hillside in rainforest and in the secondary alluvial forest. On the Ramu River, he recorded it as characteristic of the latter, being found in places in pure stands. In Papua, White (Proc. Roy. Soc. Queensland **24**: 23. 1922) noted that the Breadfruit was "common wild or cultivated through the whole of the coastal country," while Lane-Poole (Forest Resources of Papua and New Guinea, 81. 1925) recorded it as one of the more permanent members of the regrowth on cleared land. In the "Results of the Archbold Expeditions," the Breadfruit was recorded from the Fly River region as common on flooded riverbanks and in second growth forest (Rand & Brass, Bull. Am. Mus. Nat. Hist. 77: 366, 376. 1940). It was also recorded from the Meervlakte in Dutch North New Guinea as occurring along waterways and as a marginal constituent of periodically inundated *Timonius*-forest, one of the successional communities of this flood plain (Archbold, Rand & Brass, l.c. **79**: 233, 235, 1942). A photograph of this community was published by Van Steenis (in Nieuw Guinea, ed. Klein,

Pt. II. Veg. en Flora, 228. *t. 2*. 1954). Lam had earlier noted its abundance in this region (Fragmenta Papuana, transl. Lily M. Perry. Sargentia **5.** 1945), and in his review of the vegetation and flora of the whole of New Guinea (Blumea 1: 120. *map*. 1934) he described the Breadfruit as a locally frequent constituent of the extensive freshwater swamps. Further west, the Breadfruit was recorded as frequent in the inner part of MacCluer Gulf by Engler in the enumeration of plants collected by Naumann on the voyage of the *Gazelle*. (Bot. Jahrb. 7: 451. 1886). However, Rand and Brass have expressed doubt as to whether the Breadfruit is indigenous in New Guinea, and they took its presence in the Fly River area as "an indication of the presence of human population." As they stated, it is indeed difficult to establish its occurrence in undisturbed climax forest. Nevertheless, several collections have been seen which do appear to be from such forest. The best attested of these is *Brass & Versteegh 13537*, "frequent tree of primary rain-forest, on slope of a ridge, 650 m. alt." There seems to be no conclusive reason for doubting that the Breadfruit is truly indigenous in New Guinea; moreover, the seeded form shows a wider range of variation there than anywhere else. It evidently is capable of competing with other indigenous species, although its presence is admittedly most conspicuous in the secondary forest.

The seeded Breadfruit shows in New Guinea the full range of variation indicated in the description of the species, except, perhaps, in the shape and surface of the syncarp and in the shape of the male head. It may be noted once more how variable the indumentum is in colour, distribution, abundance, and type and length of hair. The collections listed above include all that were seen from New Guinea. Their provenance is indicated and none was stated to be cultivated, except possibly *Brass 981*, although some of those from secondary or riverside forest, or for which there are no data, may have been planted. With the exception of *Carr 11633*, *11675*, *15726* (secondary or riverside forest) and *Clemens 1117* (no data), which will be discussed below, their inflorescences may be described as follows. The syncarps are ellipsoid to cylindric, with slender flexuous processes projecting to 5–15 mm., and the male inflorescences are narrowly cylindric, 20–30 (–37) × 1.5–2 cm. This appears to be the indigenous form of the Breadfruit in New Guinea. *Artocarpus leeuwenii* and *A. papuana* of Diels both represent this form. The type of *Artocarpus leeuwenii* (*Docters van Leeuwen 11163*) has a dense indumentum throughout, and the syncarp processes (erroneously called styles) project to 12 mm., whereas the type of *A. papuana* (*Ledermann 7513*) has less indumentum and the syncarp processes project only 5–7 mm. Intermediate collections have been seen, however. The type of *Artocarpus incisa* Linn. f. var. *muricata* Beccari resembles that of *A. leeuwenii* in the syncarp characters, but has a sparser indumentum.

The four collections which were excepted above show a wider range of variation. The syncarp on *Carr 15726* has low, broad, obtuse processes on the surface and a number of apparently well-developed seeds. *Carr 11633* has a syncarp covered by conical processes projecting to 3 mm. and has

only one seed. A similar, possibly entirely seedless, syncarp was seen on *Clemens 1117*. This collection is also of interest since on the specimen at the Arnold Arboretum some of the male inflorescences measure only 11–13 × 1.5–1.8 cm. at anthesis, although on that at Leiden there is one measuring 25 × 1.6 cm. A note on the label at Leiden suggests that this may be a mixed collection. *Carr 11675* has a male inflorescence measuring 15 × 1.1 cm., at anthesis, so that there is evidently fairly wide variation in both male and female inflorescences in collections from secondary and riverside forest. It must be pointed out that all the syncarps seen are ellipsoid to cylindric and that none is undoubtedly seedless. Thus the "characteristic" seedless Breadfruit of the Pacific, with a globose head and a nearly smooth surface has not been seen in New Guinea. Too much emphasis should not be placed on this apparent absence since so few syncarps have been seen, and none is definitely from a cultivated plant. Brass (Bull. Am. Mus. Nat. Hist. 111: 97. 1956) notes that the seeded Breadfruit is cultivated on the Cape Vogel Peninsula for its seeds, and Barrau (Subsistence Agriculture in Melanesia. Bishop Mus. Bull. 219: 59. 1958) states that, especially in New Guinea, the seeds are preferred to the flesh, although the latter is also eaten. It is of interest to note that Ochse and Backhuizen van den Brink (Veg. Dutch E. Ind. 489. 1931) record that F. J. F. van Hasselt, a missionary at Manokwari, stated that the Papuans sliced Breadfruit (presumably few-seeded or seedless) and dried it for storage over a period of time. In view of the variability and apparent overlapping of characters, there is no reason why the few-seeded or (?) seedless varieties should not have arisen in New Guinea.

There is no definite evidence as to whether the Breadfruit is indigenous in Melanesia and the Moluccas. In Melanesia, Guillaumin's observation that it is common in the rainforest on Eromanga in the New Hebrides (Jour. Arnold Arb. 13: 106. 1932) is based on a field note, the only one seen from the whole region, on *Kajewski 394* (A, K). This collection has deeply incised leaves with broad sinuses. The inflorescences are at anthesis; the male head is clavate, measuring 13 × 2 cm., and the female head is obovoid with conical processes projecting 1 mm. However, too much significance cannot be attached to this single record of the status of the Breadfruit, since it is possible that the forest was secondary. Daniker (Viert. Naturf. Ges. Zürich 77: Beibl. 19: 125. 1932) recorded the Breadfruit as doubtfully spontaneous on the Loyalty Islands. The only other fertile collection seen from Melanesia is *Mosely s.n.* (BM, K) from the Admiralty Islands, with male heads measuring 20–26 × 3 cm. at anthesis. It may be noted that the single fertile collection seen from New Caledonia, *Balansa 3233* (P), has a seeded fruit with low facets and a clavate male inflorescence 7 × 2.3 cm.

In the Moluccas, the only source of detailed information is Rumphius, who described (c.1660–1680) distinct seeded and seedless forms in the "Herbarium Amboinense." The former, *Soccus granosus*, had narrowly conical processes on the syncarp and more or less pubescent twigs and leaves, while the latter, *Soccus lanosus*, had low facets on the syncarp and

was glabrous. Rumphius recorded that he had been told that the Breadfruit grew wild on Banda. All the collections from the Moluccas cited above are stated to be from either old or primary forest, but all are sterile, and no other fertile collections from these islands have been seen. In their vegetative characters the collections lie within the range of variation shown by those from New Guinea, but none is as densely pubescent as the type of *A. leeuwenii* and most are subglabrous. Both to the east and west of New Guinea, therefore, the range of variation is apparently fairly wide, but whether these forms could have been derived solely from the apparently indigenous Breadfruit of New Guinea cannot be determined until more adequate material is available. This problem will be discussed further below under Micronesia.

In the Pacific region (i.e., Micronesia and Polynesia) the Breadfruit is chiefly of importance in its seedless form and the variation exhibited by this will first be indicated briefly, since more evidence is available concerning this form than the seeded form. A list follows of the more important references which give lists of Breadfruit varieties under their vernacular names. In the ensuing discussion, where only the date is given after an author's name, it refers to a work in this list.

CHRISTIAN, F. W. The Caroline Islands, 386. 1899. [43 varieties (two seeded) on Ponape, with brief notes on the fruits.]

SEEMANN, B. Flora Vitiensis, 255. 1868. [13 varieties (one seeded), with short notes on the fruits and leaves.]

CHRISTOPHERSON, E. Flowering Plants of Samoa. Bishop Mus. Bull. **128**: 72. 1935. [30 varieties, with brief notes on the fruits and leaves.]

BENNETT, G. Gatherings of a Naturalist in Australasia, 396. 1860. [24 varieties in Tahiti, with some brief comments.]

HENRY, T. Ancient Tahiti. Bishop Mus. Bull. **48**: 39. 1928. [40 varieties listed, with some short notes. The Tahitian legend of the origin of the Breadfruit is also given (p. 423).]

WILDER, G. P. The Breadfruit of Tahiti. Bishop Mus. Bull. **50**. 1928. [31 varieties described (one seeded), with photographs of the fruits and leaves. A number of the vernacular names in these three works are the same.]

CHRISTIAN, F. W. Eastern Pacific Islands, 208. 1910. [34 varieties listed from the Marquesas without descriptions.]

WESTER, P. J. Philip. Agr. Rev. **17**: 24. 1924. [A compilation of earlier lists incorporating further data from Tahiti and the Marquesas.]

The variation recorded for the seedless form of the Breadfruit in the Pacific covers the full range indicated for the species in the shape, size and surface of the syncarp, and in the outline of the leaves. The latter are usually incised and glabrous or nearly so except on the main veins, but there are a few entire-leaved varieties. These observations are based on the descriptions of Wilder (1928), on the brief notes of other authors, and on rather sparse herbarium material. On the basis of this evidence it has not been possible to distinguish any obvious groups of varieties. With closer study, however, lines of development between different varieties may well prove to be traceable and it may then be possible to determine the routes of distribution. At present it can be noted only that some of the

seedless varieties show quite a close resemblance to the seeded form of New Guinea in their elongate, "prickly" syncarps. They may be contrasted with other varieties having round, nearly smooth fruits, but all gradations and combinations of characters seem to occur between these two extremes. Seeded varieties of the Breadfruit are rare in Polynesia but have been recorded from Fiji (*uto sore*, Seemann, 1868) and Tahiti (*huero*, Wilder, 1928). It was noted above that the second of these is usually propagated by vegetative means. The fruit is globose, with few seeds and low facets, and the leaves are incised and "slightly pubescent."

The Breadfruit was distributed throughout the Pacific before the arrival of Europeans. The earliest description that has been found of it was given by Quiros, who went as the pilot on Medaña's voyage of 1595 through the southern Pacific Ocean and who, after the death of Medaña on Santa Cruz, guided the survivors of the expedition to Manila (Penrose, Travel and Discovery in the Renaissance 1420–1620, 165. 1952). Quiros recorded the Breadfruit from the Marquesas, in the east, and Santa Cruz, in the west, in an account of the voyage which he wrote in the form of a letter to De Morga, then governor of the Philippines, and which the latter included in his "Sucesos de las Islas Filipinas," published in 1609. There can be no doubt that the Breadfruit was introduced into Polynesia by man, and it may be noted that this opinion was expressed as early as 1784 by Forster in his little book "Vom Brodbaum."

In Micronesia, on the other hand, it has been stated that the seeded form is an important constituent of the lowland vegetation on some of the "high" islands. In the eastern Caroline Islands the seeded form has been recorded from all the "high" islands. Kanehira listed two seeded varieties from Truk (edible, *mei chon*; not edible [?], *aroyas*; Jour. Dep. Agr. Kyushu Univ. 4: 306. 1935). Glassman noted two seeded varieties in Ponape, which frequently grew without any cultivation (*mai-pa*, *mai-kohlch*, Bishop Mus. Bull. 209: 11. 1952; cf. *pa*, *koli*, Christian, 1899). On Kusaie, Volkens (Bot. Jahrb. 31: 416. 1901) recorded the Breadfruit (not stating whether it was seeded) from lowland forest. He also mentioned that there were seeded varieties on Yap, but apparently regarded them solely as planted in mixed groves of useful and strand trees. Volkens stated that in the Carolines as a whole most of the primary forest had been destroyed, except on very steep slopes, and Glassman also noted that on Ponape most of the vegetation at low elevations was secondary. Although the seeded form is evidently able to maintain itself, as in New Guinea, in secondary vegetation, authentic records of its occurrence in virgin forest in the Carolines are lacking. Seeded varieties are also recorded from "low" islands in this group, namely, Pingelap Atoll (*mei sabarak*, St. John, Pacif. Sci. 2: 109. 1948), and Namonuito and the Hall Islands (Stone, l.c. 13: 89, 90, 100. 1959). These records indicate that seeded as well as seedless varieties must have been distributed by man in this area; Stone notes that the seeds are a favourite article of diet.

In the Marianas, a seeded form of the Breadfruit called *dugdug* was stated by Safford to be very abundant on Guam (Contr. U. S. Natl. Herb.

9: 55, 190. 1905). Dr. F. R. Fosberg, who has studied this form in the field, has been kind enough to send me the manuscript of a paper he has written on the Breadfruit in Micronesia. He also expresses the doubts indicated above as to the status of seeded varieties of the Breadfruit in the Carolines, but he states that in Guam the *dugdug* is dominant in some of the least disturbed original forest, especially in limestone areas. Its characters are somewhat distinctive and Dr. Fosberg describes the leaves as often entire (although very variable in their outline on the same tree) with conspicuous, brown, appressed hairs on the main veins beneath, the male inflorescences as short (to c. 10 cm. long), and the syncarps as more or less short-cylindric with low facets at maturity. This form was described by Trécul as *Artocarpus mariannensis* from a collection made by Gaudichaud, *sine numero*, in the Marianas Islands. The collection probably comes from Guam, which Gaudichaud visited in 1819 with the Freycinet expedition. The type specimen in the Muséum National d'Histoire Naturelle, Paris, has entire leaves, which are glabrous except for appressed colourless or pale rufous hairs on the underside of the main veins, and an immature male inflorescence with a cylindric head measuring 7 × 1 cm.; the vernacular name is given as *doug-doug*. The few fertile collections seen from Guam indicate that the seedless form of the Breadfruit there, called *lemai*, likewise has rather short, stout male inflorescences, but that the leaves are incised.

From this review it is evident that, throughout the Pacific, the Breadfruit exhibits a range of variation, at least in the shape of the syncarp, beyond that seen so far in collections from New Guinea. On the other hand, in the Pacific region the leaves tend to be subglabrous except on the main veins, and no specimens have been seen with such a dense indumentum as the type of *A. leeuwenii*, which may be regarded as representing almost the extreme of variation in this direction of the presumed indigenous form in New Guinea.

Nevertheless, until additional fertile collections are available, especially from New Guinea and the Carolines (none at all has been seen from the latter area), it is felt that the pattern of variation in the Pacific cannot be established with sufficient certainty to justify the separation of the Guam form of the seeded Breadfruit as a distinct subspecies or species. If this should be a distinct indigenous form and if it has hybridized with an introduced form of the Breadfruit in the Micronesian area, as is suggested by Dr. Fosberg, the characters of the Guam form could account for the greater range of variability of the Breadfruit in the Pacific than in New Guinea. However, it has been indicated in the course of this review that there is a considerable scatter of the characters of this form in the western Pacific area and that most of them (entire leaves, rufous hairs, fairly short male inflorescences and low anthocarp apices) also turn up in collections from New Guinea. There is a possibility that the *dugdug* of Guam represents a very early introduction of a rather distinctive type, developed in the Carolines or in New Guinea, which became naturalized and flourished in part due to lack of competition from the relatively small indigenous flora.

It must be pointed out in this connection that the Breadfruit has a large seed with no powers of dormancy. Furthermore, only two other species of the genus extend farther east into New Guinea than the Vogelkop; of these one extends into the Solomon Islands.

Dr. Fosberg discusses and has drawn my attention to the considerable range shown in the Pacific and elsewhere in the minute details of the indumentum of the leaves (even when consisting of only scattered hairs on the main veins), and differences in the hairs may be of great assistance in tracing the alliances of the different varieties.

In spite of the lack of material from the Carolines it seems that this scattered group of islands may have been a centre of differentiation and of distribution for seedless varieties of the Breadfruit. This is also suggested by the distribution of the names for the Breadfruit which is outlined below, and by the wide range of variation in fruit characters indicated by Christian's notes on seedless varieties in Ponape (1899). This range is apparently as wide as that found farther east and includes the characters of the seeded forms of both Guam and New Guinea. To show to what extent Micronesia was a centre of origin for seedless varieties from seeded trees requires further study, both there and in New Guinea.

Two names for the Breadfruit are widespread in the Pacific, as was pointed out by Christian in 1897 (Jour. Polynes. Soc. 6: 127. 1897). Their distribution is northerly and southerly respectively, but they overlap somewhat, especially in eastern Polynesia. The more northerly of the names is *mai* or *mei*, which occurs in the Caroline and Marshall Islands (Christian, l.c. and 1899, and other authors), in Niue, east of the Tonga Islands (Yuncker, The Flora of Niue Island. Bishop Mus. Bull. 178: 46. 1943) and in Samoa, the Marquesas, and Mangareva in the Tuamotu Archipelago (Christian, 1910). It is also found as *lemai* in the Marianas and as *rima* in the Philippines. The southern name appears as *ulu* in Samoa (Christopherson, 1935), as *kuru* in the Cook Islands (Wilder, Flora of Rarotonga. Bishop Mus. Bull. 86: 40. 1931), and as *uru* in Makatea. In the Tuamotu Archipelago *ura* is recorded from Anaa (Brown, Flora of Southeastern Polynesia — III. Dicotyledons. Bishop Mus. Bull. 130: 37. 1935) and *kuru* from Mangareva (Christian, 1910). Wilder (1928) records that in Tahiti the name for the Breadfruit used to be *uru* ("head"), but that it is now *maiore*. In Hawaii the Breadfruit is called *ulu* and MacCaughey (Torreya 17: 37: 1917) states that the plant was probably introduced there from Samoa. In Fiji, the word for Breadfruit is *uto*, meaning "heart," according to Seemann (1868). Two names which are somewhat similar to those of wide distribution in the Pacific are recorded on collections from New Guinea — *momu*, *momoi*, and *mow* from the Vogelkop, and *unu* from Papua. However, in view of the many and various local names that have been noted for the Breadfruit in New Guinea and Melanesia (Christian, Jour. Polynes. Soc. 6: 128. 1897; Barrau, Jour. Agr. Trop. Bot. Appl. 4: 119. 1957) it would not be justifiable to assume that there is necessarily a direct relationship. Although in the Carolines the Breadfruit is most frequently called *mai*, in the Palau Islands and Yap, which are in the west-

ern part of the group, it is known by the names *medu*, *methu*, *thu*, *su* and other variants which are all probably cognate (Christian, l.c.; Barrau, l.c.). Further east in the group, in Kusaie, it is called *mos* or *mosse*, and this name is also recorded, as *mossi*, for Northeastern New Guinea (Christian, l.c.). No obvious correspondences can be traced in the names of varieties, except between neighbouring islands; thus Niue has evidently received its varieties from Samoa (? or Tonga), while Makatea shows some relationship with Tahiti.

The status and variability of the Breadfruit in the rest of Malaysia, apart from New Guinea and the Moluccas, which have already been discussed, will now be considered. In the Philippines the seeded and seedless forms of the Breadfruit are rather different from each other and they were described by Blanco in 1837 as *A. camansi* and *A. rima* respectively, the specific epithets being derived from their Tagalog vernacular names. (He applied the name *Artocarpus incisus* to the indigenous species now called *A. blancoi*.) The Breadfruit has been regarded as an introduced plant in the islands by some authors, including Merrill (Fl. Manila, 176. 1912, Enum. Philip. Pl. 2: 40. 1923), and this view of its status is supported by the absence of any definite records, either in the literature or on field labels, of its occurrence in the wild, except in secondary vegetation. This may be contrasted with the fairly abundant herbarium material of *A. blancoi* and *A. treculianus*. Merrill's record of *Artocarpus communis* from the Lamao Forest Reserve, Luzon (Philip. Jour. Sci. 1: Suppl. 43. 1906), and Whitford's records of the species as a constituent of dipterocarp forest in various parts of the Philippines (Philip. Jour. Sci. 1: 373–431, 637–679. 1906; l.c. Bot. 4: 699–723. 1909; Bull. Bur. For Philip. 10(1): 23, (2): 29. 1911) must, for the most part, be referred to other indigenous species of this series. However, it appears that the Breadfruit does occur in the degraded forest called *parang* (Whitford, Philip. Jour. Sci. 1: 391. *t. 4, 5*. 1906).

Quisumbing, however, in 1940 (Philip. Jour. Sci. 72: 331) revived the name *Artocarpus camansi* Blanco for the seeded form of the Breadfruit in the Philippines and expressed the opinion that it was an endemic species, closely related to, but specifically distinct from, the ancestor of the Polynesian Breadfruit. The *camansi* has a narrowly oblong-obovoid male head, 15–25 cm. long, and narrowly conical processes on the syncarp, projecting 5–8 mm., whereas the *rima* (which Quisumbing referred to *A. communis*) has a club-shaped male head (8–15 cm. long in the collections examined in this study) and a nearly smooth syncarp. However, specimens representing the *camansi* which have been examined (*e.g., Merrill SB 830*) resemble rather closely others seen from New Guinea and, although the seeded breadfruit is apparently naturalized in Luzon, it seems most probable that it has been introduced from New Guinea or the Moluccas. The rather marked differences shown by the seedless *rima* are due to its introduction from a different source, which was almost certainly the Marianas. The seedless *lemai* of Guam resembles the *rima* in the club-shaped male head, the names are cognate, and there was contact with Manila through the Spanish galleons. Wester made this suggestion in 1924 (Philip. Agr. Rev.

17: 24) on the basis of the absence of any mention of the Breadfruit in the Philippines in de Morga's "Sucesos de las Islas Filipinas" (1609) and the inclusion by G. J. Kamel of *Rhymay Marianorum* (together with *Dugdug Marianorum* and *Camangsi*) in his list of Philippine plants (in Ray, Hist. Pl. 3: App. 52. 1704).

The seeded and seedless forms of the Breadfruit are both cultivated in western Malaysia, and they are similar to the forms described by Rumphius in the "Herbarium Amboinense" from the Moluccas and noted above. The seeded form has distinct processes on the syncarp and more or less abundant indumentum, while the seedless form (which may have a few inviable seeds) has an almost smooth syncarp and is glabrous or nearly so. The latter was described by Hasskarl in 1842 as *Artocarpus laevis*. The earliest mention of the Breadfruit in western Malaysia was made in 1642 in a brief description in Bontius' "De Medicina Indorum" (p. 52), which apparently refers to this species, although a remark on the objectionable odour of the fruit suggests some confusion with the Chempedak (*Artocarpus integer*). This description reappeared in Bontius' "Historiae Naturalis & Medicae Indiae Orientalis Libri Sex" (p. 119), as edited and published by Piso in 1658 in his "De Indiae Utriusque Re Naturali et Medica." An illustration of the Breadfruit was added, but the vernacular name was given as *Champidaca*; further reference is made to this confusion under *A. integer*. The three works mentioned in this paragraph, together with Kamel's list, contain the only references in pre-Linnaean botanical writings to the Breadfruit.

The differences just given between the seeded and seedless forms of the Breadfruit seem to hold, with minor variations, throughout the rest of the tropics, but the specimens and descriptions available are not adequate for this to be stated with certainty.

It is not known when the Breadfruit was first carried westward from Malaysia, but it is cultivated in Ceylon and along the western coast of the Deccan peninsula. According to Thunberg (Philos. Trans. Roy. Soc. London 69: 470. 1779) it was introduced into Ceylon in 1727 or 1728 from the Maldive Islands, but no confirmation of this statement has been found in the later literature.

The Breadfruit was introduced to Mauritius from Luzon in the eighteenth century by Sonnerat, who described it under the name *rima* (Voy. Nouv. Guin. 99. *t. 57–60*. 1776), but it was not established on the African continent until the nineteenth century, according to Chevalier (Revue Bot. Appl. Agr. Trop. 20: 29. 1940). It was mentioned by Ficalho in 1884 (Pl. Uteis Afr. Port. 273) for the Portuguese dependencies and Chevalier (l.c.) states that it was introduced into French Guinea in 1897. It is now common along the coastal region of west tropical Africa.

In the New World, the Breadfruit was introduced into the West Indies at the end of the eighteenth century, following representations by the planters as to its potential value in providing a staple food for the slaves (see Howard, Scientific American 188: 88. 1953). The Society of Arts, in London, offered rewards for its introduction and establishment, and

details of these, with reports on the progress of the trees, appeared in their Transactions for the period 1783–1807. The seeded form was brought to Martinique from Mauritius by a French ship in 1792 (Robley, Trans. Soc. Arts 20: 357. 1802). The introduction of the Breadfruit by Captain William Bligh is, however, far better known. In 1787 he set out from London in the *Bounty*, largely through the influence of Sir Joseph Banks (see Cameron, Sir Joseph Banks, K.B., P.R.S., The Autocrat of the Philosophers. 1952), to collect young plants from Tahiti and carry them westward to the West Indies, but soon after the *Bounty* left Tahiti in 1789 this attempt terminated in the famous mutiny. In 1791 Bligh set out once more in the *Providence* and arrived at St. Vincent and Jamaica in 1793, bringing with him the seedless form of the Breadfruit from Tahiti, together with a few plants of the seeded form from Timor. An illustrated account of both forms, based on material from St. Vincent was published by W. J. Hooker in 1828 (Bot. Mag. 55: *t. 2869–71*).

In South America, Tavares (Broteria, Ser. Vulg. Sci. 13: 25. 1915) states that the Breadfruit was first cultivated in French Guiana in 1811, and that it was introduced from there to Brazil, where only the seedless form is known. The Breadfruit is also frequently grown in the coastal regions of Central America and, as Standley and Steyermark observe (Fieldiana Bot. 24(4): 12. 1946), it may have been introduced there from the west by early Spanish voyagers.

12. **Artocarpus pinnatisectus** Merr. Philip. Jour. Sci. 18: 50. 1921, "*pinnatisecta*," Enum. Philip. Pl. 2: 43. 1923. Holotype, Luzon, *Escritor BS 20789* (PNH, destroyed); isotypes (K, US); lectotype (US).

Tall tree (fide Merrill). *Twigs* 15–20 mm. thick, shallowly rugose, glabrous except for tufts of patent greyish or pale rufous hairs to 3 mm. long below the stipular scars and petioles; stipular scars 2 mm. broad, not prominent, conspicuous; lenticels in a ring below scar. *Stipules* 10–20 cm. long, lanceolate, acute, villous with patent, pale rufous hairs, to 3 mm. long. *Leaves* c. 40–100 × 35–60 cm., oblong to oblong-ovate in outline (fide Merrill), deeply pinnatifid, lateral lobes c. 12–20 pairs, lanceolate, attenuate, to 18 × 2 cm. (*Escritor BS 20789*) or to 38 × 6 cm. (*Ramos & Edano BS 33536*), sinuses narrow, extending to within 1.5 cm. of midrib; midrib and main veins of lateral lobes prominent beneath, reticulum slightly so; glabrous above, main veins appressed-puberulent beneath, and with scattered longer hairs; lateral veins of lobes to c. 25 pairs; intercostals few, parallel or not; drying pale to dark brown; hypodermis absent; gland-hairs immersed, heads flattened, c. 16-celled; petiole 70–100 mm. long.

Inflorescences solitary in leaf-axils (only male head seen attached). *Male head* (immature, deformed on both sheets) of two laterally connate lobes each to 70 × 25 mm., smooth, covered with flowers, a few of these sterile, and occasional interfloral bracts, the sterile perianths solid and pro-

jecting c. 0.5 mm. from the surface; perianths tubular, 2.4 mm. long, bilobed, lobes with deflexed inflated hairs having acute tips; stamen immature, filament fairly slender, anther-cells oblong, 1.2 mm. long; bracts slenderly stalked, heads narrowly peltate, 0.2 mm. across, with a tuft of hairs 1 mm. long; peduncle (two laterally fused) 25 × 5 mm., with sparse patent rufous hairs. *Syncarp* (submature) 15 × 5 cm., cylindric, drying red-brown, covered by closely set, fleshy, short-cylindric, obtuse processes, 3 × 2 mm., rough from the acute, deflexed tips of inflated hairs; simple styles exserted to 1.5 mm.; scattered bracts present between the processes, slenderly stalked, heads narrowly peltate, 0.2 mm. across; wall 1.5 mm. thick; seeds . . . ; core 25 mm. across; peduncle . . . .

DISTRIBUTION: Philippine Islands (Luzon and ? Mindanao).

Philippine Islands. LUZON. Quezon (Tayabas): Guinayangan, *Escritor BS 20789*, Mar. 1913 (K, US, ♂). Camarines: Paracale, *Ramos & Edano BS 33536* (A, K, US, ♀).

This species is based on very inadequate material. Only two collections have been seen, these bearing immature male inflorescences and a detached, submature syncarp respectively. However, although the specimens differ in the size of their leaves, they agree in the large number of lateral lobes (12–20 pairs as compared with 7–10 pairs in *A. multifidus*), and their association seems justified in view of the differences from the other species already noted under the series. In the original description Merrill cited a third collection, *Cruz FB 27751*, Davao, Mindanao, but no duplicates of this have been found and it was not stated whether it was fertile. Both the isotypes show the same abnormality of the male inflorescence, which has the appearance of two inflorescences fused laterally and presumably developed from a partially divided rudiment. Merrill made no reference to this and gave the dimensions of the head as 10 × 3 cm., and the length of the peduncle as 3 to 4 cm.

13. **Artocarpus multifidus** Jarrett, sp. nov. Holotype, Samar, *Sulit 6462* (PNH); isotype (A).

Inflorescentiae floribus fertilibus, plerisque perianthiis solidis praelongis, bracteisque raris obtectae; folia profunde pinnatifida, laciniis utrinque 7–10, glandulis immersis, capitibus planis 8-cellis, sine hypoderme.

Arbores ad 10 [–20] m. altae. [*Ramuli juniores* 15–20 mm. crassi, rugosi, infra cicatrices stipularum annulatas, 2 mm. latas, prominulas, conspicuas, villosi, pilis patentibus, pallidi-rufis, 3 mm. longis, lenticellisque circum ramulos dispositis. *Stipulae* 18–23 cm. longae, late lanceolatae, acutae, tenuiter villosae, pilis patentibus, pallidi-rufis, 3 mm. longis.] *Folia* [40–] 90 cm. longa, ovati-oblonga, [profunde pinnatifida,] sinusibus angustis, costa tenuiter villosa, in sicco brunnea; laciniae utrinque [7–]10, lanceolatae, leviter falcatae, attenuatae, ad 32 × 7 cm., nervis mediis lateralibusque subtus prominentibus, nervis transversalibus venulisque subtus prominulis, nervis mediis tenuiter villosis, nervis lateralibus utrinque ad

FIG. 13. Left, *Artocarpus pinnatisectus*, paratype, *Ramos & Edano 33536* (K); right, *A. multifidus*, holotype, *Sulit PNH 6462* (PNH).

25, rectis, pubescentibus, pilis [rectis vel] uncinatis, nervis transversalibus non parallelis; hypodermis absens; glandulae immersae, capitibus planis, 8-cellis; petiolus [70–]130 mm. longus.

Inflorescentiae axillis foliorum solitariae. [*Capitula mascula* (immatura) ad 80 × 25 mm., clavata, plana, floribus fertilibus numerosissimis, plerisque sterilibus, 2 mm. exsertis, obtecta; flores fertiles perianthiis tubulosis, 2.5 mm. longis, supra bilobatis, puberulentibus, staminibus filamentis cylindricis, cellis antherum oblongis, 1.5 mm. longis; flores steriles cylindrici, solidi, 4.5 mm. longi (ad 2 mm. prominentes), apicibus clavatis, pilis recurvatis; pedunculus 50 × 3 mm., tenuiter villosus.] *Syncarpium* (maturum) 12 × 5 cm., cylindricum, in sicco brunneum, processibus crebris duarum longitudinum, carnosis, teretibus, obtusis, asperis, pilis recurvatis, subinflatis, inaequalibus, longioribus crispis, obtectum; processus longiores flexuosi, 15 × 1 mm., solidi, breviores 5 × 1 mm., perforati, stylis bifidis, 2 mm. longis exsertis; bracteae interflorales rarae, tenuissimae, anguste peltatae, capitibus 0.2 mm. latis, pubescentibus; stratum externum syncarpii c. 2 mm. crassum; "semina" (pericarpia indurata) numerosa, ellipsoidea, 10 × 7 mm., stylis sub-basalibus, perianthiis liberis tenuisque inclusa; embryum radicula ventrali, cotyledonibus aequalibus fere in longitudinem positis, testa tenuiter pergamentacea inclusum; axis syncarpii c. 20 mm. diametro; pedunculus 50 × 7 mm., tenuiter villosus.

DISTRIBUTION: in forest to 2000 ft., Philippine Islands (Samar, Mindanao).

Philippine Islands. SAMAR. Mt. Calbiga, Taft, *Sulit PNH 6462*, May 1948 (A, PNH, ♀). MINDANAO. Surigao: Mt. Kabatuan, *Mendoza & Convocar PNH 10563* (A, PNH, ♂).

The characters of this rather distinctive species are discussed above, under the series.

(To be concluded)